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# Cultural and Social Values of High-School Chemistry

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CULTURAL AND SOCIAL VALUES  
OF HIGH-SCHOOL CHEMISTRY

By

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A Thesis submitted to the Faculty of the Graduate  
School of Loyola University in partial fulfillment of the  
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## CHAPTER I

### INTRODUCTION

All science courses in general have aimed to impart a certain body of scientific information, to develop the ability to think scientifically, and to develop certain so-called scientific attitudes. However, with the gradual change in educational objectives in general there results a shift of emphasis in the various subject areas. In the teaching of high-school chemistry the cultural and social values of the subject are receiving increased attention. These values relate primarily to attitudes, points of view, and ideals and can be learned as well as facts. They are as important a part of education as the more purely mental things.

#### The Problem

The present study will endeavor, first, to determine the social and cultural values of high-school chemistry recognized by educational authorities as desirable and possible, and secondly, to compare these values with the objectives proposed for education in general by the Educational Policies Commission of the National Education Association of the United States and the American Association of School Administrators.

#### The Procedure

Aims and objectives in chemistry teaching are discussed by writers working in the field of chemical education, are stated by authors in their textbooks, and are listed by education experts in books dealing with instruction in chemistry. The procedure, therefore, included, first, an

analysis of all articles relevant to the problem which appeared in the educational periodical literature during the five-year period, 1936 to 1940; secondly, an examination of fourteen high-school chemistry textbooks published during the same five-year period; and thirdly, an examination of books on the teaching of chemistry, on curriculum construction, and on methods of teaching at the high-school level.

The values found in each of the three sources were recorded separately on cards from which the classification was made and the tables assembled.

These values were then compared with the educational objectives proposed by the Educational Policies Commission in order to determine to what extent authorities in science education are in accord with the objectives proposed by the Commission. The objectives were proposed by this Commission in 1938 and form the most authoritative statement on objectives thus far enunciated.

Periodicals. - The writer analyzed all the articles which appeared during the period 1936 to 1940 in five periodicals devoted to science teaching and which dealt with chemical education at the secondary-school level. In addition the writer also analyzed articles which appeared in educational periodicals other than those purely scientific in character. These latter articles were determined by reference to the Readers' Guide to Periodical Literature and to the Education Index.

The five periodicals devoted primarily to science instruction are: the Journal of Chemical Education, published monthly by the Division of Chemical Education of the American Chemical Society; the Science Counselor, published quarterly by the Duquesne University Press for the benefit of teachers of science in Catholic high schools; Science Education, the official

journal of the National Association for Research in Science Teaching; School Science and Mathematics, published by the Central Association of Science and Mathematics Teachers; and the Science Teacher, published quarterly and serving state and regional associations.

Textbooks. - Reference to the Cumulative Book Index showed that fourteen textbooks in high-school chemistry were published in the United States during the five-year period, 1936 to 1940. The fourteen textbooks were obtained from the various publishing companies.

Books by Education Experts. - Reference to the Cumulative Book Index revealed the fact that four books in the teaching of science at the secondary level were published during the five-year period under consideration. During the period 1931 to 1935 two books on the teaching of chemistry were published and three books on the teaching of science. Because of the small number of books on science education published during the period 1936 to 1940, the five books that appeared during the earlier period were also included in the present study. In addition the writer examined also those educational books published since 1936 which deal with curriculum construction and methods of teaching at the high-school level, since books of this class contain chapters devoted to the teaching of chemistry. Books not available at the nine libraries to which the writer had access were obtained through the Inter-Library Loan.

#### Definition of Terms Used

"Cultural values" as used throughout this study will imply whatever produces changes in the thinking, feeling, and acting of the student whereby his outlook is enlarged and his appreciation increased.

"Social values" will refer to whatever produces changes in the thinking, feeling, and acting of the student which result in the increased happiness and well-being of the social group, and therefore make him a contributing and cooperating member of the group.

"Education Experts" shall be used to include all authors of books on the teaching of chemistry, on the teaching of science, on the teaching of the secondary-school subjects, and on curriculum construction.

#### Related Studies

As far as the writer can determine no study has been made of cultural and social values of chemistry. However, Marguerite Harms in 1937 analyzed the replies to a questionnaire of 150 Louisiana chemistry teachers who rated cultural, vocational, and college preparatory objectives in their own teaching. The data gave sufficient evidence that chemistry is taught in the high schools of Louisiana chiefly for its cultural value, and that the teachers are warranted in emphasizing this objective, at least insofar as student demand and student needs are concerned (61).

In 1930 Hunter and Knapp made a study of science objectives. Their findings are based on the responses of 393 teachers and heads of science departments to a questionnaire on aims in science teaching. The study showed that only 0.5% of 1158 responses mentioned cultural aims for science teaching. The report did not state what was included in the term "cultural aims." Moreover, aims like "understanding one's environment," "imparting knowledge of one's environment," "appreciation of one's environment," and "interest in one's environment" were each evaluated separately (72).

In 1932 Beauchamp reported the results of a survey made at the request



of the government on the condition of science education in the United States. The survey included an analysis of thirty courses of study in high-school chemistry constructed during the period 1925 to 1932. Of the thirty courses only nineteen stated objectives. The objectives most frequently mentioned were a better understanding of one's environment and an appreciation of the contribution of science to mankind - each objective having been mentioned seven times (6). Beauchamp, however, does not differentiate between objectives that may have cultural value and those that may have other values.

#### Limitations

The results of this study have two limitations. First, the subjective element unavoidably entered into the selection of values suggested by the objectives which were stated by the authorities quoted. Secondly, lists of science objectives fail to distinguish clearly between the objectives of education in general and those peculiar to the study of science.(108).

## CHAPTER II

### A BRIEF SUMMARY OF CHEMISTRY TEACHING IN THE UNITED STATES

#### Three Types of Secondary Schools

The history of chemistry teaching in the United States can be better understood when viewed against the background of the development of the secondary school in this country.

The Latin Grammar School was the earliest type of secondary school in the United States. It developed, flourished, and declined in the period between 1635, when the first one was established in Boston, and 1825 when it ceased to be an important factor in secondary education. The curriculum offerings were Latin and Greek and by 1725 some courses in mathematics (47). The Latin Grammar School prepared boys for college and since the colleges taught no chemistry there was no need for teaching it in the Latin Grammar School. Moreover, such fundamental discoveries as those of Priestley and Lavoisier, Dalton and Faraday were not made until the period was well under way (106).

The Academy formed the second type of secondary school. The academy movement began in Pennsylvania in 1751 through the influence of Benjamin Franklin in answer to the demand for more practical training made by the growing middle-class. In contrast to the restricted curriculum of the Latin school the Academy offered a wide range of subjects - many of them poorly organized and poorly taught (75).

The third type of secondary school was the high school. Since the academy was not in the control of the people, was not accessible to the

many, charged tuition fees, and took the boy or girl away from home, many of the larger cities established secondary schools organically connected with the elementary schools (75). The first school of this kind was the Boys High School of Boston, established in 1821 (47). The high school was controlled and supported by the citizens. Its aim, however, did not differ from that of the Academy. "It did not concern itself with preparation for college, but looked toward giving a free, practical, and cultural education to the children of the municipality" (75:63-64). By 1860 it was evident that the Academy could not survive and it was just as evident that the public high school was an established educational institution (105).

#### Periods in the History of Chemistry Teaching

According to Preston "the history of science courses in American high schools can be conveniently divided into three periods, between which no hard and fast lines can be drawn, and for which the dates here given are merely approximate. These are:

1. The early period, lasting over two centuries to about 1870.
2. The period in which the colleges secured and held domination over the secondary schools.
3. The recent period, in which the secondary schools have gradually and increasingly loosed the college shackles and reestablished themselves in greater degree as schools for the masses rather than for the college-preparatory group only" (106).

Fay agrees with Preston on the three periods, and also states that since the various periods blended into each other no exact boundaries can be set. However, he would have the early period include the first eight or nine decades of the nineteenth and the first decade or first decade and a half of the twentieth century; and the last period, the years since about 1910 or 1915 (31).

### The Early Period

The Introduction of Early Chemistry Courses. - The early period saw the introduction of chemistry into the academy and the high school. The academy was the first American secondary school to provide instruction in chemistry. "The evidence regarding the curricula of the early academies is meager, but the indication is that a few of these schools were offering courses in chemistry by 1810" (99). Newell states that prior to 1820 about forty educational institutions had been established in America and in over half chemistry was a part of the curriculum. Records of the dates when chemistry was authorized, introduced, or first taught in certain institutions are incomplete and in a few cases documentary information is lacking altogether. "The date when the teaching of chemistry actually began in certain institutions is likewise open to verification because of doubtful or contradictory records" (96:677). The New Salem Academy was offering chemistry as early as 1795. The Onondaga Academy, New York, introduced chemistry in 1813 and by 1828 of the fifty incorporated academies in New York State alone, eighteen were teaching chemistry (33).

The teaching of chemistry in the public high schools apparently

paralleled the development of this branch of instruction in the academy. "The early New England high schools had less diversified curricula than the academies. In the second high school to be established in Massachusetts, the Worcester Female High School, chemistry was taught the first year, 1824. In the following year it was required in the Girls High School at Boston" (1540). Powers, however, disagrees here. He states that the Boston High School for Girls was founded in 1826 and that it was the first to provide definitely for instruction in chemistry. The course of study stated that as much chemistry as would be useful in domestic economy should be included (105). Be that as it may, the fact remains that girls took chemistry as early as 1825. A Massachusetts state law passed in 1857 and repealed in 1898 required chemistry to be taught in all the high schools in towns of five hundred families and over. "It would be a mistake," says Fay, to conclude that the subjects prescribed by this law were always 'taken'; often there may not have been a sufficient demand" (43:1541).

Although the high-school movement was more tardy in getting under way in the Middle Atlantic States, the Central High School of Philadelphia introduced chemistry into its curriculum as early as 1842 and the Lockport Union School in New York in 1848 (27). The early high schools west of the Appalachians had curricula that were distinctively realistic and utilitarian. In some of these schools as many as eight to ten short science courses were offered. In this section chemistry was less popular than either natural philosophy, physical geography, or botany (43).

By 1860-1865 chemistry was generally being offered in the larger public high schools (99) and its position in the curriculum was firmly established shortly after the middle of the nineteenth century. In 1867

Henry Barnard made a study of the public schools in thirty of the larger cities of the United States and found that chemistry was being taught in twenty-six of them (43).

It should be noted that during this period there was a gradual change from academy to public high school. This change, however, is of little significance to a study of chemistry teaching since it was a change in administration and financing rather than of subject matter and methods (106).

Content of Early Chemistry Courses and Methods of Teaching. - The content of the early chemistry courses was necessarily meager, for chemistry as a secondary-school subject was but in the embryonic stage. "Many of the textbooks employed were of the catechism type, and seldom were references made to the development of the science. Even the names of Priestley and Lavoisier were denied a place in them" (74:383). Despite the fact that cheap paper and the modern processes of printing were unknown at this early date, Powers states that the number of textbooks available must have outrun the demand, for by 1836 a total of twenty-seven texts written or revised by either American or English authors was being offered for sale (105). In a detailed study Fay discovered that the publication of early chemistry texts reached its peak in the ten-year period between 1850 and 1859. During that period fifty-nine texts were published (43). Superficiality and lack of originality characterized these early texts. Since the majority of the authors wrote in several fields of science, one is justified in concluding that their knowledge in any one field could scarcely have been very profound. Often, too, college texts were used, especially in the academies, and hence no attempt was made by authors to distinguish between the textbooks intended for college and for secondary school use (43).

The chemistry teaching during this early period is variously described. Jaffe says it was "superficial, informational, and practical" (74:383). Fay designates its informational character, its utilitarian nature, its superficiality, and its memoriter character as its most obvious features (43). Newell adds that the methods except in a few cases were superficial and rudimentary (96). Facts were cataloged, laws and hypotheses were learned by rote, and much was memorized; consequently, owing to this informational character of the course, the fact that many of the teachers lacked scientific training was not an insuperable handicap. "Many teachers were able to acquaint themselves sufficiently with the facts of chemistry to give their pupils in turn some smattering of chemical knowledge" (43:1538). Powers quotes Francis Wayland's words to the American Institute of Instruction: "I have no doubt that thousands of the pupils of the somewhat advanced schools have gone through a system of chemistry supposing that they have studied that science without ever having witnessed a single experimental illustration, and whose whole knowledge consisted in the recollection for a few weeks of some of the terms of the chemical nomenclature" (105:499). This statement indicates quite clearly that the textbook and question-and-answer method was by necessity widely predominant.

Some of the teaching, however, was done by what is now termed the lecture-demonstration method - the demonstrations being mainly for spectacular effects (96). It is quite true, since chemistry deals with many unfamiliar things, that in some schools the need for clear visualization was recognized. Frequently, therefore, provision was made for some demonstration to be done by the teacher to insure the creation of those images with which the new and unfamiliar words and ideas of chemistry were associated (106).

As might be expected, the apparatus as first assembled was crude and clumsy. A textbook by Amos Eaton bearing the date 1822 gave directions for making or borrowing from a druggist such apparatus as might prove useful. Frequently larger and more valuable pieces of apparatus, when financial conditions warranted, were ordered from England. A survey conducted by the United States Bureau of Education in 1878 revealed that of the 154 high schools that offered some instruction in chemistry, seventy-three illustrated the work with demonstrations which were prepared and presented by the teacher (105). Our judgment of these early chemistry teachers must not be too severe, for this science was just beginning and its content was gradually being enlarged by the scientific discoveries that were being made.

The end of the early period was marked by the introduction of chemical laboratories for the use of pupils. The high cost of apparatus and equipment and the difficulty of getting chemicals had been a great hindrance to the introduction of chemistry as a laboratory subject in many high schools. According to Norton the first high-school laboratory to be equipped in the United States was opened in 1865 at Boston (100). Frank, however, maintains that by 1865 provision had been made in many high schools for laboratory instruction. He adds that a few schools had laboratories, though poorly equipped, as early as 1854 (47). The Central High School of Philadelphia entered a new building in 1854 in which provision was made for a room to be used as a chemistry laboratory which, however, was not equipped until some years later. The first high-school building erected in St. Louis (1854) also contained a chemical laboratory equipped for student use (105). In the 1878 survey conducted by the United States Bureau of Education referred



to above, fifty-six schools reported provision for some individual laboratory work by pupils.

An account of early chemistry teaching in the United States would be quite incomplete without a brief reference to the career of Benjamin Silliman (1779-1864). "The life work of this great teacher of chemistry runs through this period like a golden thread" (17:696). Silliman exercised a wider and a more lasting influence upon the history of chemistry teaching in America than any other teacher. In a paper read before the Divisions of Chemical Education and History of Chemistry of the American Chemical Society at Buffalo in September, 1931, Browne said of him: "I suppose nearly every one in this audience can trace his chemical ancestry through this or that teacher back to Silliman and I like to think that something of the liberality, benevolence, and optimism of this grand old teacher has descended through all his pupils and their pupils to the present age" (17:697).

Objectives of the Early Period. - All during this early period utilitarian values were stressed. Facts were stored mentally against the time of probable need. There was neither time nor thought for the purely cultural elements of chemistry when every value of science was measured in terms of service and function. These forces reflecting an industrial revolution made it very difficult for educators to emphasize anything but the immediate utilitarian values in the teaching of such a practical subject as chemistry. "Facts, facts, and more hard facts was the cry which quickly drowned any voice that might have protested that this philosophy was alien to the true spirit of science teaching" (74:383).

### The Period of College Domination (1870-1910)

Influences. The second period of secondary chemistry teaching began during the last quarter of the nineteenth century. Shortly after the middle of the century various outside influences were gradually affecting the complexion of high-school chemistry courses. These influences brought about significant changes in the aims of chemistry teaching. With changes in aims there followed also corresponding changes in the content and the organization of courses and in the methods of teaching. The changes in aims, in content, and in methods were not always simultaneous, but they synchronized somewhat roughly (43).

The status of chemistry as a college subject had direct bearing on college dominance over chemistry at the secondary level. The close of the last century saw what Smith and Hall term the "struggle for rank." There were university elite who were opposed to chemistry being admitted into college curricula on the same ranking as the classics. The opponents claimed that the scientific course could not possibly be of equal value with the classical. On this ground universities frequently refused the bachelor of arts degree to the graduates of the science course (114). In 1872 colleges and universities began setting up standards for the acceptance of chemistry as a college entrance requirement. "This meant the beginning of college domination over chemistry courses in the secondary schools" (72:43).

The first really decisive step was taken by Harvard College "when in 1888 it included chemistry for the first time among the subjects that might be offered for admission, and, through Professor Cooke's Laboratory Practice, issued in the same year, defined the kind of work which it considered to be

the true educational equivalent of the other and older preparatory school studies" (114:19).

It soon became quite evident that many teachers did not know what would be acceptable to the colleges and universities and how they might best meet the requirements as to subject matter. Desirous of proving helpful, some of the colleges went so far as to plan definite courses of study to be pursued, even embodied them in textbooks compiled by members of their own science departments. To insure a group of well-prepared college freshmen many universities set up rigid requirements. "In general these requirements took the form first of prescription by the college of certain artificial standards to be met. The science must be taught by a college-trained teacher; a definite minimum amount of time must be allotted to its study weekly for a stated number of weeks; the textbook used must be approved or prescribed by the college; a fixed minimum amount of laboratory work must be done, and a notebook containing a record of it must be presented as a part of the examination to be passed for entrance; in many cases there was also required a laboratory examination to be taken at the college itself" (106:27).

The second influence to affect high school chemistry was exerted by the great European centers of research. This influence though indirect was none the less potent. To study abroad and take the doctoral degree in one such center was one of the surest ways of securing a position on an American university staff (106). Thus the research specialist's point of view with emphasis on laboratory work was passed on to the secondary-school teacher and by him impressed upon secondary-school chemistry classes.

Secondary chemistry teaching was also greatly influenced by the recommendations of the Committee of Ten, a sub-committee of the Committee on

Secondary School Studies of the National Education Association (1893). The Committee of Ten, made up of subject specialists, urged that chemistry for high schools should be based primarily upon college preparation and stressed particularly laboratory work. Among the twenty-two recommendations it stated that at least two hundred hours be given to the study of chemistry in high school, that at least one-half of this time be devoted to laboratory work, that careful notebook records of the laboratory work be kept by the student, that the laboratory record should form part of the test for admission to college (121). Worthy of note is the committee's condemnation of the practice in high schools of preparing separate courses for pupils of the non-college group.

A fourth pressure group was the Committee on College Entrance Requirements of the National Education Association, the most representative educational body in the country. The committee recommended that at least four periods a week be given to chemistry, and that half of these periods be of double length spent in the laboratory. They added that a longer time than this would be required if chemistry appeared before the third year of the course (114).

There were obvious reasons for the amount of dictation on the time to be allotted to chemistry. At the beginning of this period the sciences were still struggling for recognition and a foothold and, therefore, had to content themselves with brief periods of twelve weeks. Furthermore, the colleges felt that there should be a certain amount of articulation between high-school and college chemistry. Articulation, however, was impossible as long as some high-school chemistry courses consisted entirely of general

chemistry, others almost entirely of qualitative analysis, while still others dispensed with the laboratory (114).

A fifth power which exerted an influence upon the standards of high-school chemistry teaching was the American Chemical Society through its high-school committee. This organization was founded in 1876 for the advancement of chemistry and the promotion of chemical research. Obviously, its viewpoint also was that of the specialist. Preston maintains that in some respects this influence is perhaps "to be regretted, for it is that of a group rather powerful numerically, made up of members interested primarily in the content of their favorite science, and it is wielded upon an institution whose primary purpose is not the dissemination of content knowledge but rather the development of human beings as ordinary inhabitants of a civilized community, with relatively little thought of specialization" (106:64). The influence of this committee may be inferred from the fact that seventeen of the thirty courses of study examined by Beauchamp in 1932 acknowledged indebtedness to the American Chemical Society for its topics and objectives(6).

Aims, Content, and Method. During the period of college domination there is evidence of a shift in objectives and consequently also in content and in method of teaching. The utilitarian and practical aim of the early period gave way to that of training the mind, and mental discipline became the commonly accepted aim (74). This was the period of faculty psychology and the doctrine of formal discipline. Under the impetus of disciplinary aim subject matter was systematized and formalized (118).

The laboratory work became essentially a means of memorizing subject matter. It was organized after the German plan of methodical examination

and cataloging of all available facts. Fixed courses of experiments in definite order with elaborate notebooks in which each experiment was "written up" came to be the practice. Laws were verified by set experiments and formulas were memorized to be used in the solution of problems (47). "The textbooks followed the strictly logical cookbook system of organization" (78). As stated above they were prepared by college professors who in many instances simply abbreviated their college texts to fit the high-school needs as they understood them (47).

Evaluation of College Influence. Preston, summarizing the effect of college domination of secondary science, applicable especially to chemistry, believes the early influence more helpful than harmful for the reason that along with other sciences chemistry was lifted to a position of greater importance through college recognition, while the schools through their efforts to meet the requirements laid on them were brought to a greater degree of standardization upon a higher level. Later on, however, this influence became less and less beneficial because it forced upon high-school students courses and textbooks unsuited in content and method. It also forced all pupils, no matter what their later prospects were, to pursue the college preparatory course (106). Thus, as Frank adds, it brought the high school to a point where it ceased to function for the benefit of the greater number of students (47). The establishment of secondary-school laboratories and the beginning of real laboratory procedure is believed by Hunter to have been an additional benefit (72).

Harrison contrasts very briefly the status of high-school chemistry before and after college domination. In 1876 the prevalent view was that chemistry had little educational value; in 1901 chemistry was found in every

high-school curriculum. In 1876 school boards were loath to spend anything for laboratory or chemical equipment; in 1901 these items received first consideration. In 1870 no college accepted chemistry for admission; after 1900 no institution refused to accept it (62).

#### The Period of Revolt (1910-1933)

Influences. The third period in the teaching of high-school chemistry represents a reaction against college domination, against college preparation as the chief function of chemistry teaching, and against the disciplinary aim. The date is not marked by any one special event; many causes contributed to this spirit of dissatisfaction with the existing order. One reads suggestions like the following: "Devote a day to headache preparations, expose the patent medicine frauds that advertize in the local paper, study the community water supply. If some college professor or examination board thinks that the students' time could be better spent in studying the compounds of magnesium or the properties, think the matter over and see if you can agree with him" (75:191); "Do not design the course primarily to satisfy college entrance requirements. Some day the colleges and universities will recognize that the training which best fits a man for life should be acceptable as an entrance requirement" (75:192); "The notion should be completely forgotten that the high school is a preparation for college. The high school should declare its complete independence of college domination" (86:210); "Efforts have been made to remove the subject (chemistry) from the college preparatory straight-jacket and make it meet the needs of modern life" (46:1025).

The above quotations carry the implication of a growing realization on the part of educators that their work is to teach the child and not subject

matter, which becomes valuable only in as far as it supplies the needs of the child. This realization may be considered one of the chief causes for revolt.

A second cause was an economic one and may be said to antedate the first. The growing prosperity of our country during the first decade and a half of the present century with a consequent improvement in the financial condition of many families resulted in an increased high-school enrollment. The percentage of college-preparatory pupils decreased and in some cases the percentage became very small indeed. If as public institutions these high schools were to be administered in a way to give the greatest good to the greatest number, the value of thus directing their energies toward college preparation became highly questionable (106).

Content and Method. - With a changed viewpoint of the function of the high school consequent upon the influx of a new type of student came also a change in the content and method of teaching chemistry courses. This latter change has been extremely slow, in fact, it may be said to be going on still.

Three additional factors may be said to have contributed to what might be called a "reconditioning" of the chemistry textbook content. Hunter names two, the World War, and the demand of the common people to know more practical chemistry directed to the needs of human betterment (72). The World War had greatly emphasized the discoveries of chemistry and had advanced chemical industry in the United States. The hundreds of new achievements had their effect upon the youngsters in school. They also wanted to know something about chemistry and a sudden demand for chemistry was felt in both colleges and high schools (40). A third factor is scien-



tific investigation, which has enriched both the college and the high-school course. It is to be regretted, however, that the new was added to, instead of substituted for, much that might have been discarded. Consequently, high-school texts became too crowded for effective teaching (36).

The laboratory method so unduly emphasized during the period of college domination had to be changed with the increased enrollment. "Chemistry teaching soon proved to be expensive. Large laboratories were needed. A large budget was needed for supplies many of which, in most cases, went down the sink" (40:209). Efforts to minimize the cost of teaching chemistry to a large group of students resulted in the substitution of demonstrations by the teacher for pupil experiments (46). The problem of lecture-demonstration method versus laboratory method became the subject of many studies. Most of the evidence warrants "the general suspicion that the laboratory method fails to give adequate returns for the time and money invested" (103:201). Strong, however, believes that it is not a question of "lecture-demonstration versus individual laboratory method", but "lecture-demonstration plus individual laboratory method" (117).

Significant Developments during the Period of Revolt. - Significant educational developments during the period of revolt proved most beneficial to chemistry teaching. One such development was a better understanding on the part of college entrance examination boards. Up to this time each college had set its separate admission examinations entirely according to its own ideas. Secondary-school science teachers now asked to have a share in making out the examinations on the ground that the schools knew better what could reasonable be expected of them. Accordingly, the high schools secured representation on the newly constituted College Entrance Examination Board (106).

The Board tries not to be too dogmatic. It adopts as its definition in chemistry those topics which a commission appointed by the board and consisting of both high-school and college teachers agree upon as essential (110).

In 1920 the Committee of Chemical Education of the American Chemical Society made a gesture toward a better understanding between college and high-school chemistry. In order to bring about correlation between the two the committee drew up a standard minimum course containing twenty-eight topics. The committee claimed to have received thirty thousand criticisms on this course and accordingly revised it in 1924 (24).

A second development which vitally affected the objectives of chemistry teaching was a shift in the aims of education in general. An attempt was made to lead education to a broader conception which stressed the functional requirements of the learner (118). The expression of this attempt is embodied in the report of the Commission on the Reorganization of Secondary Education appointed by the National Education Association. The report, published in 1918 under the title Cardinal Principles of Secondary Education, stated that education should contribute to health, command of fundamental processes, worthy home membership, vocation, civic education, worthy use of leisure, and ethical character (119). In 1920 the Committee on the Reorganization of Science published its report, in which it attempted to show more clearly wherein the materials of the specialized sciences could be utilized better to achieve the larger social goals set by what came to be known as the "seven cardinal principles" (120).

The recommendations of the Committee on the Reorganization of Science were the most authoritative statements concerning the sequence in science

to be provided thus far (79). For the high school of medium size, (two hundred to five hundred pupils), it recommends chemistry for the third year with emphasis on the home, farm, and industries; for the large high school instead of chemistry "differentiated elective courses to meet special needs and interests"; for the small high school, (less than two hundred pupils), chemistry and physics. These latter courses were to be elective and to alternate in successive years (120). The Standard Minimum High-School Course in Chemistry referred to above included among its eleven objectives these two: to show the service of chemistry to the home, health, medicine, agriculture, and industry; and "to help pupils find themselves, that is, to discover whether they have an aptitude for further study in chemistry" (24:87).

A third notable development was an increased desire on the part of chemistry teachers to organize into associations. In 1914 there were relatively few associations of chemistry teachers and these only in the older and more thickly settled sections of the country. A positive advance in the right direction was the growing number of chemistry teachers' organizations. An opportunity was thus given for united effort in approaching the teaching phase and teachers could be greatly benefited by mutual assistance, exchange of ideas, and free discussion (29).

Summarization of the Three Periods. - The changes and advances during the three periods of chemistry teaching in the United States may briefly be summarized as follows: (a) Objectives emphasized first the practical and utilitarian, then college preparatory, later the functional; (b) The content at first was largely descriptive and informational, later logically organized and highly theoretical, and finally broad, covering a wide range of

material; (c) The catechetical and lecture method with infrequent teacher demonstration gave way to the lecture and individualized laboratory method stressing verification and descriptive experiments, which in turn was followed by the lecture-demonstration method now becoming increasingly popular.

#### The Present Status of High-School Chemistry Teaching

The present period in chemistry teaching may be said to have begun in 1933, for it was not until four years after the financial crash of 1929 that high-school chemistry classes began feeling the full impact of the boys and girls that industry could no longer absorb. Their need further complicated the already existing problems.

The conclusion "The present status of science teaching is difficult to determine" (118:13) may well be applied to chemistry. The question of objectives is the all-important and the most complicated problem. It is all-important since the objectives must function as criteria for the selection of subject content. It is most complicated because so many authorities and would-be authorities are offering as many different solutions.

Two groups are interested in chemical education at the secondary level. The activities of the first group center about a critical evaluation and a redefinition of objectives and the reorganization of subject content (105). In 1928 Monroe and Weber stated: "There have been several attempts to determine what the objectives of the several science subjects should be, but the accomplishments up to date are fragmentary. In fact the present writers have not been able to locate descriptions of progressive practices that appeared to be sufficiently significant to justify their inclusion" (89:369).

In 1932 a committee of specialists appointed by the National Society for

the Study of Education in A Program for Teaching Science accepted as the general aim of all education: "life enrichment through participation in a democratic social order" (92:42). The objectives for high-school chemistry that illustrate the point of view of the committee are listed as: (a) the development of understandings of those fundamental concepts of chemistry that will enable them better to interpret their environment; (b) the learning to use the processes of reflective thinking; (c) the development of attitudes towards the facts and principles of chemistry that will serve as guides in problem-solving (92).

The report of the Committee on Correlation of High-School with College Chemistry for the American Chemical Society (1936) stated that the objectives for high-school chemistry should differ from college objectives, that the high-school viewpoint should be informational, broadening, and cultural as contrasted with the technical, professional, and specialization attitude of the college. It adds that the members do not believe that a separate college entrance course is necessary or advisable on the ground that certain fundamental topics must be taught in any type of course in chemistry. The report concludes with a list of eleven essential topics, the revised list on the society's original twenty-eight topics of 1920 (67).

In 1938 the Committee on the Function of Science in General Education of the Progressive Education Association published its report, Science in General Education. The report does not pigeon-hole the different sciences but deals with them all as they have bearing upon personal living, immediate personal-social relationships, and economic relationships. The report explains how the teaching of science can be made to contribute to the student's

understanding of himself and of his social and physical environments. Applied to chemistry the term "functional chemistry" best describes the position of the Committee (118).

At present the Division of Chemical Education of the American Chemical Society has a committee cooperating with a similar committee of the National Education Association. Their combined efforts are concentrated on the problems related to the teaching of chemistry. The American Chemical Society conducted a Summer Workshop in High School at Western Reserve University, Cleveland, during the summer of 1940. A suggestive course, a start in a new direction, was developed.

Probably the most recent, most authoritative, and most comprehensive statement on the nature of educational objectives has come from the Cooperative Study of Secondary School Standards since the Cooperative Study "involved the cooperation of hundreds of educators in all parts of the country during six years since its formal organization in 1933" (71). This group has formulated its principles on the theory that "The school exists primarily for the benefit of boys and girls of the community which it serves" (71). It maintains that the objectives of education would be based on the needs of the individual, the needs of the community of which the individual is a member, and the needs of the nation of which the community is a part. It further maintains that the aims of each subject area should be such as to contribute to the attainment of the general aim. The second of its eighteen basic principles reads: In a democracy the fundamental doctrine of individual differences is as valid for schools as for individuals. "There should be no inflexible insistence upon uniformity and rigidity of organization,

method, and standards for all secondary schools in all parts of the country through any arbitrarily imposed accreditation procedures" (71:17).

The implications for chemistry teaching may be summarized from the checklist of outcomes in the principal subject matter fields: to recognize the part played by chemical reactions in the human body, in nature, and in medicines, cosmetics, clothing, and industrial processes; to learn to reason correctly from data to conclusions; to acquire skill in the use of laboratory equipment; and to learn to employ a critical attitude toward claims in advertisements of commercial products (42).

From divers channels come many attempted solutions of the problem of subject-matter organization. One attempt is discernible in the movement toward gradual integration of subject matter. Wiley believes it is seen more closely in connection with the changes that have been taking place in the field of chemistry and physics (126). A fused course in the physical sciences in which chemistry and physics are integrated is being developed at the Lincoln School of the Columbia University Teachers College. The Cleveland high schools are offering a similar course to their non-college or general pupils during the fourth year. Senior Science, as the course is called, is not designed to replace physics and chemistry but rather to complement them (21). A similar course is also being developed in the high school of Teachers College of Nebraska University (128). Some schools are offering two separate courses in chemistry, one for the prospective college students, the other for the non-college group (67). In Detroit the college preparatory group takes the standard course, the rest, a course in descriptive chemistry. California high schools are developing what is variously

called "core", "basic", or "social living" courses largely as a reaction against highly specialized and highly departmentalized instruction. Thus physics and chemistry supply material for the course of less technical character than either of the subjects (31). The Progressive Education Association has expressed itself in the Report of the Committee on the Function of Science in General Education (1938). The report does not deal separately with the different sciences but explains how the teaching of science can be made to contribute to the pupil's understanding of himself and of his social and physical environment. It points out what should be done to integrate science teaching more closely with the entire school program (118).

Efron suggests a "differentiation of schools, as opposed to the differentiation of courses within the framework of a single school, may prove the means of rendering American science teaching a more significant and functional instrument" (38:280).

Since most of the students in the public schools do not go to college, Bancroft advocates a course in "pandemic" (for all the people) chemistry rather than the introductory course they now have. He adds: "We shall have to educate the colleges to the point of accepting this work for college entrance" (3:399). In a course of this nature the applications of chemistry are more strongly stressed than in the more conventional course and the significance of chemistry in the world's work is more fully brought out (106).

Margery Gillson in 1937 made a detailed study of the use that man and women make of chemistry in their later lives. Since the uses men make of chemical knowledge differs from the uses women make of it, she suggests developing a high-school chemistry course adapted to the differentiated needs of boys and girls. On the basis of her data she advocates that the chief change in the



subject matter of the usual high-school chemistry course should occur in the second semester (54).

There is also a trend toward emphasis on the consumer's viewpoint. A course in consumer chemistry - the testing and the making of many of the products pupils contact in daily life - is being offered as another solution (91).

The second interested group is focusing its attention on the "much" that is wrong in chemistry teaching. The chemistry course should not try to fit the vocational needs of all students, because the course in chemistry contributes something to every educational objective. An attempt to satisfy the needs of all tends strongly to render the course uninteresting to all save a shifting minority of pupils (81).

Georges advocates the humanizing of physical science courses and adds that the present traditional courses are inadequate for that humanization (52). Hall would agree, for he maintains that the major portion of the textbooks and courses of study in chemistry which are in use today are organized essentially in the same manner as they were ten to fifteen years ago. However, he sees a trend toward new textbooks which can truly be called high-school chemistry, not abbreviated general college chemistry (59). Glascoe still finds the high-school chemistry course a slightly simplified college course, the subject matter being identical. The only difference is the smaller size page and a little coarser type used for the high-school book. "The high-school course in chemistry is an anomaly, a paradox. It fails to conform to requirements; it pretends to do the impossible; it is self-contradictory," is the summation of his opinion (55).

Bagley points out the folly of the notion that each community must have its own curriculum, since the American people will simply not "stay put." They are the most mobile people in the world (2:145).

Ford points to the fact that chemistry is one of the subjects greatly affected by the new programs which involve a shift away from subject-matter emphasis. He raises the question, "Does it accomplish objectives?" and adds, "To teach science is one thing and to teach about science is another" (45:556).

Beck fears that we are on the verge of losing chemistry and physics in the trend toward integration. The cause, as he sees it, lies in the fact that the old courses refused to be changed from college preparatory to life preparatory (7).

Rakestraw strongly objects to consumer chemistry and pleads for a glimpse at chemistry as a chemist sees it, not as the news reporter or the butcher (107).

Finally, Eikenberry points a critical finger at the Department of Science Instruction of the National Education Association. At present it is the only science organization that is national in scope. It could become an important factor in science teaching. It has not, however. During all the years of its existence and potential power, it has remained relatively unimportant. Its failure to attain a preeminent place is due to its woeful lack of organization (39). This indictment is somewhat humiliating, but the author offers constructive criticism.

The present status of chemistry teaching in the high schools of the nation may be summarized in terms of the major problems still to be solved by those interested - the curriculum experts, the subject specialists, the

teachers, the science supervisors, and the various organized groups. These problems center about objectives and subject content. What shall the objectives be? Shall objectives be set up in terms of ideals, attitudes, appreciations, and understandings, instead of in terms of subject matter to be covered or principles to be learned? If based on pupil need, how shall these needs be determined? What shall be the content of a course in high-school chemistry? Shall it emphasize the organization of knowledge, or shall it strive to establish understandings?

## CHAPTER III

### CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY

#### Meaning of Cultural and Social Values

When the word "culture" is mentioned, one ordinarily thinks of art, music, and literature; chemistry has seldom been thought of as "cultural." Elder was probably quite correct when he remarked, "It is a matter of record that for many years chemistry was not associated with culture, but with some low form of manual dexterity and nauseous smells" (40:209). "Culture as the term is used today includes more than an understanding or appreciation of literature, art, and music. It includes a general understanding of everything that influences man's welfare and happiness" (10:779). The writer will now attempt to show that authorities in the field of chemical education believe that high-school chemistry does possess cultural and also social values and, furthermore, an attempt will also be made to point out what these values are.

In the first place, what are cultural values and what are social values? Whatever produces changes in the thinking, feeling, and acting of a student whereby his outlook is enlarged and his appreciation increased possesses cultural value. Cultural values, then, refer to the pupil primarily as an individual. The student is a member of society which must be considered not as a mere aggregation of individuals, but as an organized group in which each member performs a special function subordinate and subservient to the welfare of the whole group as a group (4). "A method that improves the individual," says Slavson, "must needs also effect the improvement of

society, and we cannot conceive improvement in a social group which would not at the same time better individuals" (113:186). Slavson states further that an examination leads us to believe that social and cultural values are mutually inclusive (113). Gruenberg maintains that social values are essentially the same as individual values (58). It is difficult, then, to conceive of social values apart from cultural values and hence the present study makes no attempt to distinguish between them.

#### Cultural and Social Value of High-School Chemistry Indicated in Current Educational Literature

That educators are becoming increasingly aware of the cultural and social value of chemistry may be gathered from articles written by authorities working in the field of chemistry teaching. Neureiter perceives a definite trend - manifest during the last decade - toward emphasis upon the cultural content of science courses at the secondary level (94). Hall, likewise, notes that more recently aims and objectives emphasize a high-school chemistry course organized for general cultural purposes (60). Simons expresses his view somewhat similarly and concludes, "As a cultural subject of the first rank chemistry has exceptional educational merit" (112:411).

In 1928 Reverend George L. Coyle, S.J. of Georgetown University addressing the members of the National Catholic Educational Association said, "The classification of subjects as cultural or non-cultural, with an implication of inferiority of the latter, is rapidly dying out among real educators, as it is recognized that all subjects are cultural in the degree to which they develop wider appreciation of the worthwhile in life, and all subjects are aesthetic to the extent in which they open the eyes to the per-

ception of new beauty and increase the power to understand and enjoy.

Chemistry, properly taught, illuminates our common, everyday life, begets a confidence in the laws of cause and effect, the constancy of operation of Nature's laws, and shows the beauty and harmony of law and order in the world about us, increasing our interest and enjoyment in ordinary phenomena of life by our ability to understand and explain them through their underlying principles" (26:277).

Table I contains a list of the articles examined in the present study. The table gives a symbol, the writer of the article, the periodical in which the article appeared, and the date of publication. The articles are listed chronologically in the order of their appearance. Hereafter the symbol, rather than the data, will be used when reference is made to the various articles.

While all the writers quoted maintain that high-school chemistry does have rich possibilities for cultural and social values, each one views these values from his own angle.

Hopkins in his discussion of the cultural values of chemistry maintains that culture is not inherent in the subject-matter of any course. He says, "The deciding factors of any course are determined by the method of approach, the purpose for which the subject is studied, and the general attitude of mind which is carried away by the students themselves" (65:419). He holds that "chemistry offers a splendid opportunity for every teacher to bring into the classroom much of the elements of culture of the classics" (65:419).

Maxwell believes that the lack of emphasis in the past upon cultural goals has been due to the fact that only recently has the significance of definite educational objectives other than subject-matter masteries been

TABLE I  
ARTICLES IN CURRENT PERIODICAL LITERATURE  
ANALYZED IN THE PRESENT STUDY

Sym- bol	Author	Title of Article	Periodical	Date of Publication
1A	Claver, Sister M.	The Cultural Value of Science	Science Counselor	March 1936
2A	Neureiter, P. R.	A New List of Objectives for Chemistry Teaching	School Science and Mathematics	March 1936
3A	Compton, K. T.	Science in Education	Science Education	April 1936
4A	Hopkins, B. S. Mattern, L. W. Segerblom, Wilhelm Gordon, N. E.	An Outline of Essentials for a Year of High-School Chemistry	Journal of Chemi- cal Education	April 1936
5A	Agnese, Sister M.	Biographical Content of High-School Chemistry Textbooks	School Science and Mathematics	June 1936
6A	Buckham, W. B.	An Endeavor to Con- tact Objectives with Methods in the Teach- ing of Science	School Science and Mathematics	June 1936
7A	Simons, J. H.	Teaching Chemistry for Its Cultural and Training Values	Science	November 1936
8A	Deming, H. G.	A Chemist Looks at Culture	Journal of Chemi- cal Education	January 1937

TABLE I (Continued)

Sym- bol	Author	Title of Article	Periodical	Date of Publication
9A	Zechiel, A. N.	Recent Trends in Revision of Science Curricula	Educational Method	May 1937
10A	Wildman, E. E.	Double Laboratory Periods in High- School Chemistry	Science Counselor	September 1937
11A	Warren, C. C.	The Segregation of Chemistry Students as to Their Needs and Abilities	School Science and Mathematics	January 1938
12A	Fields, M. J.	Program Planning and Preparation of Outline of Work for the High-School Sciences	Science Counselor	March 1938
13A	Glascoe, P. M.	Present High-School Course in Chemistry a Paradox	Journal of Chemi- cal Education	August 1938
14A	Jaffe, Bernard	The History of Chemistry and Its Place in the Teach- ing of High-School Chemistry	Journal of Chemi- cal Education	August 1938
15A	Frank, J. O.	What Ought To Be in the Content of Health Materials in High- School Chemistry Texts?	Journal of Chemi- cal Education	November 1938



TABLE I (Continued)

Sym- bol	Author	Title of Article	Periodical	Date of Publication
16A	Goodman, Samuel	A Suggested Method for the Teaching of Chemistry to the Non-College Prepar- atory Student	School Science and Mathematics	November 1938
17A	Gill, H. E.	What the Public Expects of Science Education	Science Counselor	December 1938
18A	Curtis, W. C.	Making High-School Chemistry Practical	School Science and Mathematics	March 1939
19A	Noll, V. H.	Science as an Organized Field of Study	Science Education	March 1939
20A	Weaver, E. C.	Teacher of Chemis- try in High School	Education	March 1939
21A	Chiddix, J. C.	Activities and Science Instruction	Science Teacher	April 1939
22A	Howd, C. M.	Trends in Subject Organization in High-School Chemistry	School Science and Mathematics	May 1939
23A	Wood, G. C.	Science Teaching of Tomorrow	Science Education	October 1939
24A	Beeman, Norvil	How Much Mathematics in High-School Chemistry	Science Teacher	October 1939

TABLE I (Continued)

Sym- bol	Author	Title of Article	Periodical	Date of Publication
25A	Kostick, Max	Aims of the Laboratory	School Science and Mathematics	November 1939
26A	Wilson, S. R.	Future of Special- ized Science in High School	School Science and Mathematics	February 1940
27A	Georges, J. S.	Humanizing the Curriculum of the Natural Sciences and Mathematics	School Science and Mathematics	May 1940

recognized. He believes, moreover, that the fertility of the sciences in relation to the more practical objectives of education very likely has tended to obscure their cultural potentialities (84).

Wakeham accepting the definition of culture as "enlightenment" protests against the widely accepted notion that cultural chemistry consists chiefly of talk about chemistry. He says, "If culture, at its highest level, means 'enlightenment', a truly 'cultural' chemistry course should aim at giving the student the best possible opportunity to comprehend the essential meaning of that magnificent body of theory which has made chemistry the indispensable servant of almost all the sciences and arts and is the foundation of the amazing and all but incredible triumphs of applied chemistry during the past century" (122:260).

King sees the cultural value of chemistry in the realization of its beauty which involves simplicity of structure, clarity, and coordinated symmetry. The extent of cultural value is relative, however, since beauty is a personal discovery and as such is essentially relative. "Its definition by an individual depends alike upon his refinement in sensibility and upon his breadth of experience" (77:266).

Deming believes the cultural value of chemistry lies in the help it gives the individual to attain eminence from which he may survey the intellectual achievements of the human race in our own time as well as in former times. "The most amazing things in science are not the facts that science has brought to light, but the means by which they were obtained. Atoms and molecules, protons and electrons, quanta and cosmic rays - marvelous all of them, but the crowning marvel is that the human mind ever penetrated so far beyond the limits of the unaided human senses" (30:13).

Some writers hold that the cultural values of chemistry are derived from the appreciations it arouses in the student. Knox detects a popular tendency to stress attitudes and appreciations to the extent of minimizing the value of facts. He would not have the chemistry teacher overlook the importance of factual knowledge, since "attitudes and appreciations cannot be developed in a vacuum, but must be centered or conditioned in factual knowledge" (78:13).

Frank sums up the cultural values of chemistry thus: "Chemistry should produce a store of tastes and appreciations which should be an inexhaustible source of recreation and pleasure. The individual with a true understanding of chemistry will perceive a new beauty in nearly everything around him" (49:43).

Table II lists the values mentioned by those writers whose articles on the values of high-school chemistry appeared in periodical educational literature during the five-year period 1936 to 1940.

No attempt is made in the listing to distinguish between values that might be considered cultural or those that might be considered social, for any one outcome may possess both types of value.

The values, however, have been rephrased in terms of the student in order to secure uniformity of statement. The greatest care has been exercised in the phraseology so that the meaning of the author would not be changed. When two or more authors indicated values that were similar, the expression which seemed best to convey the idea was adopted and used in the table.

An examination of the table shows that writers propose twelve cultural and social values to be derived from a knowledge of high-school chemistry.

TABLE II

**CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY  
PROPOSED BY WRITERS IN CURRENT EDUCATIONAL PERIODICALS**

Values of Chemistry	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	13A	14A	15A	16A	17A	18A	19A	20A	21A	22A	23A	24A	25A	26A	27A	Total
1. The student acquires an appreciation for:																												
(a) The part played by science in the development of modern civilization.							x		x	x								x										4
(b) Contribution of chemistry to medicine, health, and safety.				x								x			x													3
(c) The labors and achievements of chemists.		x			x																				x			3
(d) Law and order in nature.	x	x				x																						3
(e) The service of chemistry to society.		x		x		x			x		x		x	x												x		8
(f) The service of chemistry to agriculture.				x																								1
(g) The service of chemistry to industry.				x												x		x										3
(h) The fine and the beautiful.		x						x																	x			3

TABLE II (Continued)

Values of Chemistry	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	13A	14A	15A	16A	17A	18A	19A	20A	21A	22A	23A	24A	25A	26A	27A	Total
2. He understands better:																												
(a) His natural and material environment.						x	x			x	x				x	x	x	x						x	x			10
(b) The obligations science places upon him.		x																									x	2
3. He derives inspiration from the lives of chemists.		x																										1
4. He lives and acts with greater satisfaction.	x																			x								2
5. His mental horizon is broadened.								x				x				x						x						4
6. He experiences the thrill of discovery.		x	x																						x			3
7. His life is enriched.																	x											1
8. He derives enjoyment.		x																										1
9. His leisure-time interests are satisfied.																	x		x									2

TABLE II (Continued)

Values of Chemistry	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	13A	14A	15A	16A	17A	18A	19A	20A	21A	22A	23A	24A	25A	26A	27A	Total
10. He is assisted in the choice of a vocation.				x							x					x		x										4
11. He is furnished with ideals.	x	x										x											x					4
12. His mental attitude is often changed.																					x							1
Total:	3	9	1	5	1	3	2	2	2	2	2	1	4	1	2	4	3	4	1	1	1	1	2	2	2	1	1	63

Eight of these values are characterized by a certain amount of specificity and are distinctively peculiar to chemistry. The various appreciations and understandings, the inspiration and satisfaction, the thrill of discovery and the opportunities for vocational guidance are values that can be derived from no other secondary school subject. Three values - life enrichment, enjoyment, and broadening one's mental horizon - are general and might be derived from any subject. Also, subjects other than chemistry furnish ideals. However, there is a type of enrichment and enjoyment that comes to the student only from a knowledge of chemistry. Furthermore, to state that "life is enriched," or that "one derives enjoyment," or that "one's mental horizon is broadened" is really a summarization of the specific values of chemistry.

The chart shows a rather wide diversity of opinions. However, the writers quoted do not pretend to propose what the values of chemistry should be, neither do they claim to have mentioned all of them; they simply state some of the values as they see them.

A better understanding of one's material and natural environment is the value most frequently mentioned by writers. Ten of the twenty-seven writers state this value. While a knowledge of chemistry aids a student to understand his natural environment, this knowledge enters to a greater extent into his intelligent understanding of his material environment. Chemistry has built up for him a new world quite distinct from nature - a new world of chemistry. Every moment of the day he is in intimate contact with the creations of chemistry. His daily life in the modern world and the probable changes in it which tomorrow will bring forth cannot be understood without constant reference to chemistry and its applications. Curtis states that a



knowledge of these creations will enable the student to better appreciate and adapt himself to this chemical environment (18A). Furthermore, this knowledge and understanding, Simons believes, will tend to make the student more at home in his material environment, for without this knowledge an individual can be at ease neither in his material or human surroundings (7A). Frank sees the possibility of developing a citizenry capable of living intelligently in an environment in which chemicals, and chemical principles, play a part of ever-growing importance (15A).

Eight writers state that a knowledge of chemistry gives the student an appreciation of the service of chemistry to society. Many of the technologic advances which have so profoundly affected our culture in its material aspects have their origins in chemistry. There is much in chemistry that can serve to better conditions of our fellowmen and our instruction should be such as to throw light wherever possible on the puzzling problems of human relations. Home and community are first concerns. We live as members of a society in which there is scarcely a thing used by civilized man in his daily life that has not come under chemical control before it reaches him. Indirectly the farmer, the carpenter, the garage attendant, the dentist, the doctor are all working with chemical problems (13A). It is only fitting that members of such a society should have some knowledge of the principles of science which makes the present civilization possible. The student becomes aware, as Zechiel says, of the problems created by chemical science as well as the problems solved by science (9A). The student also gets an insight, Neureiter believes, into the effects of applied chemistry on certain moral issues, such as war and peace, temperance, honesty in manufacturing, and marketing (2A). Georges and Neureiter stress the consequent need for a

realization on the part of the student of the mighty obligations which the benefits of our civilization impose upon him to preserve it as a great inheritance and his further social responsibility as a member of an interdependent environment.

The various types of appreciation are named twenty-eight times by eighteen writers. Besides the appreciation of the contribution of chemistry to the development of modern civilization and the service of chemistry to society, writers also emphasize the appreciation of the contributions of chemistry to healthful personal and social living; the service of chemistry to industry and agriculture; the labors and achievements of chemists.

Two writers see the beauty of law and order in nature - one would have the student moved to "reverence and humility toward the interdependent cosmos" (2A); the other would have him grow to an "intense love of the Creator who has made all things according to weight, and number, and measure" (1A). The first expresses an atheistic viewpoint; the second, a deeply religious attitude. Four writers see in the high-school chemistry course also possibilities for vocational guidance since chemistry familiarizes the student with occupations and professions that require chemical knowledge as a foundation. It is to the increased well-being of society that each member forming it find his proper place.

The advances made in industrial chemistry have created a greater amount of leisure with the consequent problem of utilizing that leisure to the best advantage. Since individuals give full play to their desires during leisure time, these desires should be on such a plane as will lead those individuals to aspire to better and better things to gratify their desires. To develop desires to that plane is a task almost completely new to the secondary school.

In the subject materials of high-school chemistry lie the possibilities for such development. Noll and Gill both emphasize the value of chemistry in the satisfying of avocational and leisure-time interests.

One writer mentions nine values while ten mention only one. Again, the fact that so many writers name but one value is no indication that the one named is believed by the writer to be the most important one or the only one.

Through the values proposed by writers in current periodicals, the student's outlook, then, is enlarged by a more complete understanding of the contributions of chemistry to modern civilization, and its service to industry and health; his appreciations are increased through a knowledge of the achievements of chemists and through a realization of the beauty of law and order in his material and natural environment.

#### Cultural and Social Values of High-School Chemistry Proposed by Authors of Textbooks

In the preface of Chemistry and You the authors state that during the last few years the high-school science curriculum has been given a critical examination and as a result new aims have been developed. Accordingly, new methods and a changed emphasis have been used to make these aims become realities in the lives of the students.

Most of the authors of recent chemistry textbooks are conscious of the implications of this changed viewpoint and the value of chemistry as a cultural subject is receiving increased emphasis in the subject content.

Dull states emphatically that chemistry is of cultural value and adds that the layman is prone to overlook the fact that chemistry has a place in the curriculum of culture (35). Brauer feels that his textbook adequately

supplies the cultural needs of students who will take no more chemistry (14). Masters and Floyd emphasize the cultural value of chemical history and have included brief historical sketches, and Greer and Bennett affirm that they do not underestimate the inspiration that biography illustrated by portraits may give a pupil, but portraits have been intentionally omitted from their text because too often they serve as a "medium for caricature" rather than as inspiration (57). Hopkins and his associates believe that as members of a civilized society in which there is scarcely a thing used in daily life that has not come under chemical control, it is only fitting that every one should have some knowledge of the principles of the science which makes our civilization possible (66).

Howard refers to the pleasure that may be derived from a knowledge of chemistry. He believes that an understanding of a happening will not change things, but will change us. A knowledge of the conditions which have caused rain, for example, can give us the pleasure of knowing (69).

The high-school chemistry textbook holds a very important place in the teaching of chemistry. In 1932 Beauchamp at the request of the Government of the United States made a study of the condition of science teaching in this country. He found that the textbook was of great importance in determining what was taught (6). If this condition still obtains - and there are all indications that it does - both course and unit objectives should, as Bray advises, be clearly and definitely stated by the author, that thus given proper objectives well stated, the facts presented should lead to a realization of these objectives (15).

Table III furnishes the data on the fourteen chemistry textbooks published during the five-year period, 1936 to 1940. The table gives a symbol,

TABLE III  
HIGH-SCHOOL CHEMISTRY TEXTBOOKS  
ANALYZED IN THE PRESENT STUDY

Sym- bol	Title	Author or Authors	Position of Authors	Type of Organ- ization	Date Copy- righted
1T	<u>New Practical Chemistry</u>	Black, N. H. Conant, J. B.	University Professors	34 Chapters	1936
2T	<u>Dynamic Chemistry</u>	Biddle, H. C. Bush, G. L.	High-School Teachers	12 Units	1937
3T	<u>Modern Everyday Chemistry</u>	Horton, R. E.	High-School Teacher	32 Chapters grouped into 6 Units	1937
4T	<u>Chemistry for Today</u>	McPherson, W. Henderson, W. E. Fowler, G. W.	Univ. Prof. Univ. Prof. Science Supervisor	53 Chapters grouped into 14 Units	1938
5T	<u>A First Book in Chemistry</u>	Bradbury, R. H.	University Professor	37 Chapters	1938
6T	<u>Chemistry and Its Wonders</u>	Brauer, O. L.	College Professor	14 Chapters	1938
7T	<u>High School Chemistry</u>	Bruce, H. G.	High-School Teacher	43 Chapters	1938
8T	<u>Units in Chemistry</u>	Howard, R. S.	High-School Teacher	29 Chapters grouped into 8 Units	1938

TABLE III (Continued)

Sym- bol	Title	Author or Authors	Position of Authors	Type of Organ- ization	Date Copy- righted
9T	<u>High School Chemistry</u>	Masters, W. N. Floyd, L. P.	Teachers- College Professors	38 Chapters	1938
10T	<u>Chemistry</u>	Greer, Carlotta Bennett, Cora	High-School Teachers	28 Chapters	1939
11T	<u>Chemistry and You</u>	Hopkins, B. S. Davis, R. E. Smith, H. R. McGill, M. V. Bradbury, G. M.	Univ. Prof. All High- School Teachers	16 Units	1939
12T	<u>First Principles of Chemistry</u>	Brownlee, R. B. Fuller, R. W. Hancock, W. J. Sohn, M. D. Whitsit, J. E.	All High- School Teachers	41 Chapters	1940
13T	<u>Modern Chemistry</u>	Dull, C. E.	High-School Teacher	42 Chapters	1940
14T	<u>New World of Chemistry</u>	Jaffe, B.	High-School Teacher	39 Chapters	1940

the title of the text, author or authors, the position of the authors at the time of producing the textbook, the type of organization, and the year in which the textbook was copyrighted. Hereafter the symbols, rather than the data, will be used to designate the various textbooks. The list does not follow the alphabetical order but rather for convenience the chronological.

Table IV lists the cultural and social values of high-school chemistry proposed by authors of textbooks which were published during the five-year period, 1936 to 1940.

The values of high-school chemistry proposed by authors of textbooks are expressed in the preface of the text, in an introductory chapter, or in statements preceding each unit. Statements of values are found in the prefaces of all the textbooks analyzed. In nine instances authors have also included such statements in an introductory chapter addressed to the student, and in three texts, the authors have indicated values in an introductory note preceding the units.

Again, as previously stated, the values have been expressed in terms of the student rather than in the exact phraseology of the author.

Two of the textbooks were written to meet college entrance requirements and a statement to that effect is made by each author in the preface of his book. If these two authors believe in the cultural value of chemistry, they do not indicate their belief. The two textbooks (5T and 7T) were, therefore, omitted in the compilation of Table IV. Two textbooks (10T and 13T) also contain the statement that all the material needed to meet college entrance requirements has been included by their authors. Thus of the fourteen textbooks published since 1936, only four contain a reference to college preparation as an objective.

TABLE IV

CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY  
PROPOSED BY AUTHORS OF CHEMISTRY TEXTBOOKS

Values of Chemistry	1T	2T	3T	4T*	6T	8T	9T	10T	11T	12T	13T	14T	Total
1. The student acquires an appreciation for:													
(a) The part played by chemistry in the development of modern civilization.	x											x	2
(b) The contribution of chemistry to medicine, health, and safety.		x		x	x	x							4
(c) The labors and achievements of chemists.		x		x	x	x	x		x	x		x	8
(d) Law and order in nature.						x			x				2
(e) The service of chemistry to society.		x								x		x	3
(f) The service of chemistry to agriculture.		x			x								2
(g) The service of chemistry to industry.		x			x	x							3

\* 5T and 7T omitted because authors named no cultural and social values.



TABLE IV (Continued)

Values of Chemistry	1T	2T	3T	4T	6T	8T	9T	10T	11T	12T	13T	14T	Total
2. He understands better:													
(a) The ways in which chemistry affects human life.	x	x	x			x	x	x	x	x		x	9
(b) Current literature dealing with chemical knowledge.					x						x		2
(c) The relation of chemistry to other subjects.		x		x									2
(d) His natural and material environment.	x	x	x	x	x	x	x		x	x	x	x	11
3. The student acquires increased respect for new chemical discoveries.		x					x						2
4. He derives inspiration from the lives of chemists.					x			x				x	3
5. He becomes an intelligent consumer of technical services and goods.			x										1

TABLE IV (Continued)

Values of Chemistry	1T	2T	3T	4T	6T	8T	9T	10T	11T	12T	13T	14T	Total
6. He is provided with interesting topics for conversation.									x		x		2
7. He lives and acts with greater satisfaction.			x			x		x				x	4
8. His mental horizon is broadened.					x		x						2
9. His chances for success are increased.					x								1
10. He experiences the thrill of discovery.			x		x			x					3
11. His life is enriched.					x					x			2
12. He derives enjoyment.			x			x		x	x				4
Total:	3	9	6	4	11	8	5	5	6	5	3	7	72

Bernard Jaffe, author of New World of Chemistry, and B. S. Hopkins, co-author of Chemistry and You, have each also written an article that is analyzed in the present study.

The majority of authors of chemistry textbooks likewise mention the better understanding of natural and material environment as a value to be derived from a course in chemistry - eleven of the twelve textbooks contain a statement of the authors to that effect. It is impossible to determine whether textbook authors consider this value the most important, since frequency of mention is no reliable index to importance. A better understanding of the ways in which chemistry affects human life and an appreciation of the labors and achievements of chemists are the values that receive the next most frequent mention. Brauer believes that biographical material makes a student aware of the fact that eminent chemists had to surmount all the obstacles that confront youth today (6T). Biddle and also Hopkins believe that chemistry will develop an appreciation of the chemist and the many fields he has helped to develop through long hours of labor to learn Nature's secrets (2T and 11T).

An appreciation of the contribution of chemistry to medicine, health, and safety, and the satisfaction and enjoyment that can be derived from a knowledge of chemistry are each mentioned four times, while an appreciation of the service of chemistry to society and to industry, the inspiration derived from the lives of chemists, and experiencing the thrill of discovery are mentioned three times. Horton speaks of getting a thrill from learning what things are made of (3T) and Brauer says working with new and strange substances gives one the thrill of the discoverer (6T). This thrill occasioned by a seeming discovery may be as stimulating, pleasurable, and satisfying to

the immature pupil as true research is to the mature chemist (10T).

An appreciation of the part played by chemistry in the development of modern civilization, its service to industry and agriculture are mentioned only twice. A better understanding of current literature and the relation of chemistry to other subjects, increased respect for new chemical discoveries, a broadening of the mental horizon, and life enrichment are each mentioned twice. Two authors believe that chemistry provides the student with interesting topics for conversation. Dull says that as the student may become a better reader through some chemical knowledge, likewise may he become a more intelligent talker and listener when conversation turns to chemical products (13T). Only one author mentions the fact that the student becomes an intelligent consumer of technical services and goods and one refers to the student's increased chances for success.

Most of the values, 67%, center about areas of appreciations and understanding. The broadening of the mental horizon and the enrichment and enjoyment of life, and increased chances for success are values so general and so wide in scope that they may be derived from any subject in the curriculum.

Textbook authors name seven values not indicated by writers of articles, while the writers name five values not indicated by textbook authors. Textbook authors mention a better understanding of current literature, of the ways in which chemistry affects life, and of the relation of chemistry to other subjects; an increased respect for new chemical discoveries; intelligent consumership; interesting topics for conversation; and increased changes for success - none of which are mentioned by writers. Authors, on the other hand, do not mention the understanding of the obligations science imposes, the provision for leisure, the choice of vocation, the ideals of

honesty improvided, and the change in mental attitude.

Understandings bring about a change in the thinking of a student; appreciation, respect, inspiration, satisfactions, and the thrill of discovery change his feelings; and a change in feeling results in a change in action.

#### Cultural and Social Values of High-School Chemistry Proposed by Education Experts

Table V lists the books which deal wholly or partly with the teaching of chemistry at the high-school level and which were analyzed in the present study to determine what cultural and social values of chemistry are proposed by education experts. The table gives a symbol for each book, the title, the author or authors, the classification of the book, and the date the book was copyrighted. Two of the books, one by Frank and the other by Newberry, deal with chemical education at the secondary level. They are the only books on the teaching of chemistry published during the last decade. Seven books published during the last decade deal with the teaching of science. Fourteen books on secondary education and curriculum construction published during the past five years contain statements on chemistry objectives and values.

TABLE V

## THEORETICAL BOOKS ANALYZED IN THE PRESENT STUDY

Sym- bol	Title	Author or Authors	Classification	Date Copy- righted
1B	<u>The Teaching of High School Chemistry</u>	Frank, J. O.	Chemistry Education	1932
2B	<u>An Introduction to the Teaching of Science</u>	Downing, E. R.	Science Education	1934
3B	<u>Science Teaching at Junior and Senior High School Levels</u>	Hunter, G. W.	Science Education	1934
4B	<u>The Teaching of Chemistry</u>	Newbury, N. F.	Chemistry Education	1934
5B	<u>Science in the New Education</u>	Slavson, S. R. Speer, R. K.	Science Education	1934
6B	<u>Fundamentals of Psychology in Secondary Education</u>	Garrison, S. C. Garrison, K. C.	Secondary Education	1936
7B	<u>The High School Science Teacher and His Work</u>	Preston, C. E.	Science Education	1936
8B	<u>Creative Education</u>	Crow, C. S.	Secondary Education	1937
9B	<u>Secondary Education for Youth in Modern America</u>	Douglass, H. R.	Secondary Education	1937

TABLE V (Continued)

Sym- bol	Title	Author or Authors	Classification	Date Copy- righted
10B	<u>Secondary Education Principles and Practices</u>	Engelhardt, F.	Secondary Education	1937
11B	<u>Experiences in Building a Curriculum</u>	Spears, H.	Curriculum Construction	1937
12B	<u>High School and Life</u>	Spaulding, F. T.	Secondary Education	1938
13B	<u>High School and You</u>	Simley, I. T.	Secondary Education	1938
14B	<u>Science in General Education</u>	Thayer, V. T. and Others	Science Education	1938
15B	<u>The New High School in the Making</u>	Wrinkle, W. L.	Secondary Education	1938
16B	<u>The High School at Work</u>	Belting, P. E.	Secondary Education	1939
17B	<u>The Development of a Course in the Physical Sciences for the Lincoln School</u>	Brown, H. E.	Science Education	1939
18B	<u>The Secondary School</u>	Odell, C. W.	Secondary Education	1939

TABLE V (Continued)

Sym- bol	Title	Author or Authors	Classification	Date Copy- righted
19B	<u>Psychology and Teaching of Secondary-School Subjects</u>	Reed, H. B.	Secondary Education	1939
20B	<u>Fundamentals of Secondary-School Teaching</u>	Billet, R. O.	Secondary Education	1940
21B	<u>Modern Methods and Materials for Teaching Science</u>	Heiss, E. D. Obourn, E. S. Hoffman, W. C.	Science Education	1940
22B	<u>The Curriculum of the Common School</u>	Morrison, H. C.	Curriculum Construction	1940
23B	<u>The Redirection of Secondary Education</u>	Wiley, G. M.	Curriculum Construction	1940

Table VI lists the cultural and social values of high-school chemistry proposed by education experts. Again, the understanding of one's environment is the value most frequently mentioned by the group. Of the various types of appreciation two receive more frequent mention - an appreciation of the contributions of chemistry to medicine, health, and safety and an appreciation of the labors and achievements of chemists. The authors of Modern Methods and Materials for Science Teaching write: "The emerging of science as a body of tested laws and principles has been intimately bound up with stories of romance, privation, and adventure. These should become a portion of the cultural background of every boy and girl. His intelligent adjustment to the problems growing out of this use will depend, in part, upon the extent to which he appreciates the background of their development" (21B:15).



TABLE VI

CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY  
PROPOSED BY EDUCATION EXPERTS

Values of Chemistry	1B	2B	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13B	14B	15B	16B	17B	18B	19B	20B	21B	22B	23B	Total
1. The student acquires appreciation for:																								
(a) The part played by chemistry in the development of modern civilization.													x			x			x					3
(b) The contribution of chemistry to health and safety.	x	x	x			x		x						x			x	x			x			9
(c) The labors and achievements of chemists.	x	x	x			x	x						x	x							x			8
(d) The service of chemistry to society.			x			x			x															3
(e) Law and order in nature.		x				x															x			3
(f) The service of chemistry to industry.			x					x						x										3
2. He understands better:																								
(a) The ways in which chemistry affects human life.				x		x						x	x	x		x	x							7

TABLE VI (Continued)

Values of Chemistry	1B	2B	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13B	14B	15B	16B	17B	18B	19B	20B	21B	22B	23B	Total
(b) Current literature dealing with chemical knowledge.	x																							1
(c) His natural and material environment.	x	x		x	x		x	x			x	x		x					x	x	x	x	x	14
(d) The obligations science places upon him.		x						x	x													x		4
3. He becomes an intelligent consumer of technical goods.									x					x	x		x			x	x			6
4. He lives and acts with greater satisfaction.	x													x			x							3
5. He acquires increased respect for new chemical discoveries.		x							x															2
6. He receives vocational guidance.	x			x		x		x		x			x	x			x	x						9
7. His leisure-time interests are satisfied.			x	x		x	x	x			x			x			x	x						9
8. He experiences the thrill of discovery.				x	x																			2

TABLE VI (Continued)

Values of Chemistry	1B	2B	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13B	14B	15B	16B	17B	18B	19B	20B	21B	22B	23B	Total
9. He derives inspiration.				x																				1
10. His life is enriched.						x																		1
11. He is furnished with ideals.	x			x		x																		3
12. He derives greater enjoyment.	x			x																				2
13. He is freed from superstition and unfounded beliefs.	x																			x				2
Total:	9	6	5	8	2	9	3	6	4	1	2	2	4	8	2	2	6	3	2	3	5	2	1	95

The authors quoted above strongly urge the inclusion of a fund of appreciations as one of the major goals of all science teaching. Developing appreciations is one phase of the education of the emotions which some authorities believe is as essential as, if not more essential than, education of the mind, as far as social living and citizenship are concerned. Consequently, if students can be trained to learn how to achieve wider horizons and greater depths of enjoyment, they are being prepared for continuous development of emotional power (50).

Nine of the education experts see in chemistry the possibilities for vocational guidance. The variety of experience offered by chemistry should serve, as Frank suggests, to point out to the pupil the direction of his interests and abilities. Frank goes so far as to state that through its chemistry course the high school should search for real chemical ability among its students in order to develop further any such ability thus discovered (1B).

Closely allied to the need for vocational guidance is the need for satisfying leisure-time interests. Nine of the education experts stress the value of chemistry in satisfying this need.

Although chemistry touches daily life in innumerable ways, for almost every article in the home owes its utility, its durability, or its beauty in some way to chemistry, only seven education experts, barely one-third, propose "a better understanding of the ways in which chemistry affects daily life" as a possible value.

Two education experts state that a knowledge of chemistry helps to free the individual from superstition and unfounded beliefs. Frank finds mankind still the victim of inherited superstitions, fears, and prejudices which

disturb his daily life and warp his judgment in many ways. Chemistry can give the student a new interpretative power which will help to stabilize his emotional tendencies (1B). Beauchamp believes this last-named objective to be the most important of all science objectives, and yet he found it mentioned only once in the nineteen chemistry courses that he examined in his survey.

Through a knowledge of chemistry a student can become a more intelligent consumer of technical goods and services. This value of chemistry is mentioned six times by the education experts.

Four authorities believe that a course in chemistry can help a student realize the obligation science places upon him. Douglass says the student has an obligation to contribute to further advances in scientific knowledge (9B). Crow refers to this responsibility and says that it will develop in the student an attitude of understanding and appreciation which will warrant trusting him eventually with the control of technical knowledge (8B).

Other values of chemistry proposed by this last group of authorities and mentioned two or three times by them are so broad that they can have little definite meaning; they are so general that they may be realized by other subjects in the curriculum. However, education experts do believe in the possibilities for cultural and social values to be derived from a course in high-school chemistry.

Table VII is a composite of Tables II, IV, and VI. The table shows eighteen values of high-school chemistry compiled from sixty-two sources and mentioned 230 times. The writers of articles propose twelve values which are mentioned sixty-three times by them; the textbook authors also propose twelve values (not the identical ones proposed by the writers) which are

TABLE VII

CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY  
PROPOSED BY WRITERS IN PERIODICAL LITERATURE,  
AUTHORS OF TEXTBOOKS, AND EDUCATION EXPERTS

Values of Chemistry	Writers	Text- book Authors	Edu- cation Experts	To- tal
1. The student acquires an appreciation for:				
(a) The part played by science in the development of modern civilization.	4	2	3	9
(b) The contribution of chemistry to medicine, health, and safety.	3	4	9	16
(c) The labors and achievements of chemists.	3	8	8	19
(d) Law and order in nature.	3	2	3	8
(e) The service of chemistry to society.	8	3	3	14
(f) The service of chemistry to agriculture.	1	2	0	3
(g) The service of chemistry to industry.	3	3	3	9
(h) The fine and the beautiful.	3	0	0	3
2. He understands better:				
(a) The ways in which chemistry affects human life.	0	9	7	16

TABLE VII (Continued)

Values of Chemistry	Writers	Text- book Authors	Edu- cation Experts	To- tal
(b) Current literature dealing with chemical knowledge.	0	2	1	3
(c) The relation of chemistry to other subjects.	0	2	0	2
(d) His material and natural environment.	10	11	14	35
(e) The obligation science places upon him.	2	0	4	6
3. The student acquires increased respect for new chemical discoveries.	0	2	2	4
4. He derives inspiration from the lives of chemists.	1	3	1	5
5. He becomes an intelligent consumer of technical services and goods.	0	1	6	7
6. He is provided with interesting topics for conversation.	0	2	0	2
7. He lives and acts with greater satisfaction.	2	4	3	9
8. His mental horizon is broadened.	4	2	0	6
9. His chances for success are increased.	0	1	0	1

TABLE VII (Continued)

Values of Chemistry	Writers	Text-book Authors	Education Experts	Total
10. He experiences the thrill of discovery.	3	3	2	8
11. His leisure-time interests are satisfied.	2	0	9	11
12. He receives vocational guidance.	4	0	9	13
13. He is furnished with ideals.	4	0	3	7
14. His mental attitude is often changed.	1	0	0	1
15. His life is enriched.	1	2	1	4
16. He derives enjoyment.	1	4	2	7
17. He is freed from superstition and unfounded beliefs.	0	0	2	2
Total:	63	72	95	230

mentioned seventy-two times; and the education experts propose thirteen values mentioned ninety-five times. Appreciations are mentioned eighty-one times and of this group of values the appreciation of the labors and achievements of chemists receives the most frequent mention. The writers, however, mention the appreciation of the service of chemistry to society more frequently than they mention appreciation of the labors of chemists. A better



understanding of one's environment is the value more frequently mentioned than any other single value; it is named thirty-five times in all and most frequently mentioned by each of the three groups of authorities quoted.

The writers mention two values - an appreciation of the fine and the beautiful and a desirable change in mental attitude - not mentioned by the two other groups of authorities. The textbook authors name one value - the relation of chemistry to other subjects - not included by the writers and education experts. It is only natural for textbook authors to recognize this value. Two of the textbook authors also see the value of chemical knowledge in furnishing the student with interesting topics for conversation. Neither is this last value stated by anyone in the other two groups. The experts, on the other hand, see the value of chemistry in freeing a student from superstition and unfounded beliefs - a value not mentioned by the writers or by the textbook authors.

On the whole it is the more specific values that receive the highest frequency of mention.

## CHAPTER IV

### A COMPARISON OF THE CULTURAL AND SOCIAL VALUES OF HIGH-SCHOOL CHEMISTRY WITH THE OBJECTIVES OF EDUCATION PROPOSED BY THE EDUCATIONAL POLICIES COMMISSION

#### Educational Objectives Proposed by the Educational Policies Commission

The National Education Association of the United States in conjunction with the American Association of School Administrators functioning through the Educational Policies Commission in 1938 stated the purposes of education in American democracy. The Commission under the chairmanship of Alexander J. Stoddard was composed of nineteen recognized educational leaders. The statement of the purposes of education was formulated by the Commission only after seven meetings held over a period of three years, and by a series of conferences directed by subcommittees of the Commission. In addition the Commission had the assistance of a large number of people outside its own staff and membership including experts in general and vocational education as well as curriculum specialists.

The statement of the Commission, therefore, represents the best composite thinking which we have on the subject as well as the most authoritative. The purposes of education in American democracy as stated and defined by the Educational Policies Commission will provide an accepted criterion for validating the cultural and social values of high-school chemistry proposed by writers in current educational literature, by authors of chemistry textbooks, and by education experts in their books.

The Commission begins its work by carefully defining its own position:

"Every statement of educational purposes, including this one, depends upon the judgment of some person or group as to what is good and what is bad, what is true and what is false, what is ugly and what is beautiful, what is valuable and what is worthless, in the conduct of human affairs. Objectives are, essentially, a statement of preferences, choices, values. These preferences are exercised, these choices made, these values arranged in a variety of ways" (37:1). The Commission realizes its responsibility as a group to determine what is "good," what is "true," what is "beautiful," and what is "valuable" in human affairs.

The Commission continues by explaining the sources of educational objectives, which it maintains are a form of social policy. Since the social policy "accepted and endorsed by the American people is the continued striving toward the democratic ideal," the Commission proceeds "to sweep into a few broad generalizations the minimum essentials of democracy." The essentials are summed up in the terms, general welfare, civil liberty, the consent of the governed, the appeal to reason, and the pursuit of happiness. The democratic way of life is the inclusive purpose of American education and is expressed as "the fullest possible development of the individual within the framework of our present industrialized democratic society" (37:41). The education of such an individual presents four aspects in the opinion of the Commission. "These aspects center around the person himself, his relationship to others in home and community, the creation and use of material wealth, and socio-civic activities" (37:47). The four aspects resolve themselves into four great groups of objectives. The first group, thirteen in number, describes the educated person and forms the Objectives of Self-Realization; the second group, eight in number, describes

the educated member of the family and community group and forms the Objectives of Human Relationship; the third group, ten in number, describes the educated producer and consumer and forms the Objectives of Economic Efficiency; the last group, twelve in number, describes the educated citizen and forms the Objectives of Civic Responsibility. The objectives are numerous - forty-three in all - but they are very specific. The Commission feels that addresses, books, articles, reports, and courses of study sometimes fail to affect what is done in the classroom because there has been "a tendency to deal in extremely broad generalizations which, for classroom procedure, could mean almost anything and, therefore, mean almost nothing" (37:vii).

The Commission does not intend that the four major objectives should be thought of separately, but rather that each is related to the others. Moreover, the school is only one of the many educational influences in these various inter-related fields of human life, and though its responsibility extends to all areas, it is quite obvious that in some areas the weight of education rests on the schools more exclusively than in others. Thus, the preparation for economic efficiency and for civic responsibility is largely a function of the school; while the field of self-realization is becoming more and more also a duty of the schools. The field of human relationship is shared by the school, the home, and the rest of the environment.

As the four major objectives become the responsibility of various educational agencies so also do the subdivisions of each objective become the specific objectives of each subject area in the curriculum. Thus, high-school chemistry has definite contributions to make toward the realization of objectives proposed by the Commission.

### The Educational Objectives as Criteria for Chemistry Values

Obviously, a high-school course in chemistry is not expected to contribute to the realization of all the educational objectives. Chemistry considered as a cultural subject can, however, make many valuable contributions.

The first group of objectives proposed by the Commission is composed of thirteen subdivisions that center about the processes of growth, or self-realization and, therefore, are a primary concern of education. "This concern includes, but also reaches far beyond, the memorization of the useful and useless facts which usually make up the bulk of the school curriculum" (37:52).

High-school chemistry can contribute directly to six of the objectives of self-realization.

The educated person has an appetite for learning. "The educated person in the years of his immaturity has been started upon a career of life-long learning," says the Commission (37:52). The educated person finds a sense of intellectual adventure in learning all he can about the world in which he lives. This education is "not gained in the few years in school; it is a lifetime enterprise for which formal schooling should supply a good running start" (37:53). Many of the authorities quoted in this study agree that chemistry can arouse in the student an active and wide-faring curiosity which will be an impetus to further study.

The educated person can speak the mother tongue clearly. After showing how important the spoken word has become through the medium of the telephone, the talking motion picture, and the radio, the Commission adds, "Observers familiar with social life in foreign countries often comment disparagingly

on the aridity of American efforts at conversation (37:54). Now, two textbook authors see a possible value in chemistry right here. Hopkins tells the student that a knowledge of chemistry will furnish him with interesting topics for conversation (11T), and Dull adds that the student will be a more intelligent talker and listener as well when conversation turns on such topics as paints, lacquers, foodstuffs, rayon, cellophane, drugs, or medicines (13T).

The educated person understands the basic facts concerning health and disease. Health is an important factor which conditions success in personal and social undertakings. The Commission refers to the many millions of dollars spent annually on useless and harmful patent medicines. True, the subject of health belongs more properly in the area of biology, nevertheless authorities point to valuable chemical knowledge about medicine, food, and body secretions that the student acquires from a course in chemistry.

The educated person protects his own health and that of his dependents. Authorities quoted show how a chemical knowledge leads to a better understanding of health habits and the intelligent understanding leads to improved habits.

The educated person has mental resources for the use of leisure. Since reading is one of the major forms of recreation, skill in the use of printed material for acquiring information and for intelligent understanding is of the greatest importance. Reference to chemical topics is found almost daily in newspapers and other current literature. The student who has taken a course in chemistry is thereby enabled to read with more understanding and with greater satisfaction. Also chemistry affords opportunities for discovering and developing other new and wholesome leisure-time pursuits.

Such recreative arts as photography and blue-printing have a definite place in a chemistry course.

The educated person appreciates beauty. "Beauty is one of the great desires of the human heart" (37:67). Most individuals respond to beauty in color, harmony, and form. It is one of the important functions of education to help the individual to seek, to enjoy, and to treasure beauty throughout his life. True, it is easier to teach the student the chemical and physical properties of substances, chemical laws, and theories than to give him an appreciation for the beauty and grandeur of laws and properties. It is possible, however, and the authorities quoted are quite in agreement. Contact with chemistry "offers opportunity for broadening one's horizon, stimulating one's imagination, deepening one's sympathy, heightening one's appreciation of the fine and the beautiful" (30:14).

The second group of objectives proposed by the Commission are eight in number and describe the educated individual as a member of the family and community group. The Commission terms these objectives the objectives of human relationship. They are related to the more intimate connections of the individual with his friends, his immediate neighbors, and the members of his own family group. Any values that high-school chemistry might contribute to the realization of the objectives of human relationship would be contributed quite indirectly. As stated above responsibility for attaining the objectives of human relationship is shared by the school, the home, and the rest of the student's environment. Now, since authorities quoted maintain that chemistry helps the student to a better understanding of his environment and to an appreciation of the service of chemistry to society, we see how the study does possess values for realizing the objectives of

human relationship.

The third group of objectives are the objectives of economic efficiency. They are ten in number and relate to those activities which have to do with creating and using goods and services. The Commission regrets that the major emphasis in education for economic efficiency is placed on the productive phase when consumer education, being the equal and corollary of producer education, is just as important. A course in high-school chemistry can contribute directly to the realization of three of the objectives of economic efficiency.

The educated producer knows the satisfaction of good workmanship. "In a democracy each person contributes according to his ability to the essential welfare of all" (37:91). The Commission would have the student regard work as something to be sought, enjoyed, and respected, not as something to be avoided, suffered, and despised. Authorities in the field of chemical education are quite agreed that the introduction of biographical material into the chemistry course gives the pupil a fuller understanding and appreciation of the tasks and achievements of the laboratory worker. As the student becomes more and more aware of the fact that the contributions of chemistry to modern conveniences represent hours of hard labor on the part of chemists, his admiration of the labor as well as of the chemist grows. Then, too, the student's own work in the school laboratory with the accompanying thrill of discovery and the satisfaction of work accomplished tends to make him respect labor as something ennobling. Chemistry textbook authors are including a great deal of biographical material in their texts (1).

The educated producer has selected his chosen vocation. The Commission believes that most people drift into some occupational field with the result



that there is much wasteful occupational shifting. The guidance of the school with respect to vocational adjustment will, in the opinion of the Commission help the student to survey the needs and opportunities for employment and to appraise his own potentialities and opportunities. According to the authorities in chemical education high-school chemistry offers the student rich opportunities of discovering his own inclinations and aptitudes should they lie in the field of science. Given an opportunity thus to explore vocations closely connected with science, the student can plan for his future more intelligently (14B). Simley, after giving the student some idea of the nature of a chemist's work asks, "How would you like to be one of those deep-seeing, wonder-working chemists?" (13B). Hopkins expresses the vocational guidance aspect of chemistry as "helping the student find himself" (4A).

The educated consumer develops standards for guiding his expenditures.

Since productive energy is misdirected on a grand scale by unwise consumer judgments, the Commission urges the improvement of the consumer scale of preferences, that is, he should be educated for wise consumption of goods. Consumers should, therefore, be acquainted with the most important conclusions of science and experience about human needs and the means of meeting them. Those tastes should be cultivated that are the source of esthetic enjoyment and the development and those arts and aptitudes that recreate, enrich experience, and widen the outlook should be developed. "At this point of special need in our society our educational program is weak" (37:103). The Commission realizes that education for wise consumership cannot be attained through the study of a single field of knowledge. Authorities in chemical education see in chemistry the possibilities for developing a wise consumer. Thayer agrees that a course in chemistry can

help to develop those understandings which will make it possible for the individual to select and use goods and services wisely (14B). Heiss and his associate interpret education as "complete and effective adjustment" and since consumership is an area of adjustment, they point to the value of science in aiding the student to adjust effectively to this area by helping him to become an intelligent consumer (21).

The fourth and last group of objectives proposed by the Commission are the objectives of civic responsibility. There are ten in all and they describe the educated citizen as the Commission sees him. A knowledge of chemistry can contribute to the furtherance of three of these last objectives.

The educated citizen seeks to understand social structures and social processes. Doubtless, the problems of social structures and social processes lie in the area of the social sciences. Now, each student brings to the study and discussion of these social problems a different set of values colored and determined by all his past experiences. Because the advances in chemical discoveries have vitally affected our present-day social structures, authorities in chemical education believe that a knowledge of chemistry can help to a better understanding of the social structures thus affected (19B and 14T). In this way chemistry can be effective in changing a student's standards of values.

The educated citizen has a regard for the nation's resources. Authorities quoted in this study state that chemistry can help the student in acquiring an understanding of his environment. Now, a citizen who has an intelligent understanding of his environment is open to suggestions, more readily sees the need of, and more willingly cooperates with enterprises undertaken to check the ravages upon the heritage of the nation made by

ignorance, indifference, and carelessness. Furthermore, according to six authorities one of the important values of chemistry lies in the development of an understanding in the student of the grave responsibility and obligations science places upon him.

Finally, the educated citizen measures scientific advance by its contribution to the general welfare. The Commission believes "the science instruction has been too largely concerned with attempting to produce scientists rather than with producing citizens who have an intelligent understanding of the methods, significance, and application of science, and who are determined that science shall function in the improvement of the everyday life of the people (37:114). According to authorities in chemical education a knowledge of chemistry can meet this last criterion also. They maintain that through a knowledge of high-school chemistry the student can acquire an intelligent appreciation of the services of chemistry to industry and agriculture; a better understanding of the ways in which chemistry affects daily life; and the development of an increased respect for new chemical discoveries.

The cultural and social values of high-school chemistry, therefore, have been found to satisfy twelve of the objectives of American education set by the Educational Policies Commission and used in this study as criteria.

Table VIII compares statements made by authorities in chemical education with the statements of objectives of education set by the Educational Policies Commission in 1938.

TABLE VIII

VALUES OF HIGH-SCHOOL CHEMISTRY COMPARED WITH THE OBJECTIVES OF EDUCATION SET BY  
THE EDUCATIONAL POLICIES COMMISSION

Educational Policies Commission	Writers of Articles	Authors of Textbooks	Education Experts
<p>1. Objectives of Self-Realization:</p> <p>(a) The educated person has an appetite for learning.</p>	Chemistry develops the attitudes of wonder at, respect for, curiosity about, open-mindedness toward, realization of the beauty in, and appreciation of - the truth, and its universal operation in natural law (6A).	The student finds out new things about the world around him (1T).	Chemistry gives a student a look inside the inside of things (13B).
(b) The educated person can speak the mother tongue clearly.		Chemistry can furnish you with interesting topics for conversation.	
<p>(c) The educated person understands the basic facts concerning health and disease.</p> <p>(d) The educated person protects his own health and that of his dependents.</p>	<p>High-school chemistry is deeply concerned with the reduction of accidents (13A).</p> <p>The student possesses knowledge that shall enhance public health (11A).</p> <p>The student understands the service of chemistry to health and medicine (4A).</p>	<p>The student appreciates the contribution of chemistry to medicine and to the maintenance of good health (2T).</p> <p>Chemistry helps the student to be more intelligent in his diet and health habits (6T).</p> <p>A knowledge of chemistry helps a student to avoid pain or injury (8T).</p>	<p>A knowledge of chemistry can bring about an improved state of individual and community health (6B).</p> <p>Science can contribute much to safety education, for many of the causes of accidents have science relationships (21B).</p>
(e) The educated person has mental resources for the use of leisure.	<p>His avocational and leisure-time interests are satisfied (15A).</p> <p>Chemistry provides for a worthy use of leisure (14A).</p>	<p>The student is furnished with interesting topics for conversation (11T).</p> <p>The student becomes a better reader of current literature through a knowledge of chemistry (13T).</p>	<p>Chemistry offers a basis for a proper and valuable use of an increasing leisure (4B).</p> <p>Chemistry makes possible many enjoyable and profitable uses of leisure-time. (18B).</p>
(f) The educated person appreciates beauty.	<p>The student appreciates the aesthetic aspects of chemical and natural phenomena (2A).</p> <p>Chemistry gives a basis for the aesthetic appreciation of material structures (6A).</p> <p>The student appreciates the all-wise Creator Who has made all according to weight and number and measure (1A).</p> <p>Chemistry heightens appreciation of the fine and the beautiful.</p>	The student learns to appreciate the beauty of law and order in nature (8T).	The student perceives a new beauty in nearly everything around him (1B).

TABLE VIII (Continued)

Educational Policies Commission	Writers of Articles	Authors of Textbooks	Education Experts
<p>Objectives of Economic efficiency:</p> <p>a) The educated producer knows the satisfaction of good workmanship.</p>	<p>Chemistry offers opportunity for developing a work attitude and shows pupils that real happiness can result from hard labor (16A).</p>	<p>Life stories inspire the better student to accomplishments really commensurate with his superior talent (6T).</p>	
<p>b) The educated producer has selected his chosen vocation.</p>	<p>Chemistry helps pupils find themselves (4A). Chemistry gives a foundation which shall assist a student in the choice of a vocation (11A).</p>	<p>The student becomes aware of the possibilities and satisfactions inherent in scientific work (6T).</p>	<p>Chemistry provides the student with an opportunity to explore vocations closely connected with science so that he may plan for the future more intelligently (14B).</p>
<p>c) The educated consumer develops standards for guiding his expenditures.</p>		<p>The student becomes an intelligent consumer of technical services and goods (3T). The student understands the scientific aspects of the commodities which he uses in daily living (14T).</p>	<p>The student will have developed understandings which will make it possible for him to select and use goods and services wisely (14B).</p>
<p>The objectives of civic responsibility:</p> <p>a) The educated citizen seeks to understand social structure and social processes.</p>	<p>The student learns the effects of chemistry on certain moral issues, such as war and peace, temperance, honesty in manufacturing and marketing (2A).</p>	<p>Chemistry gives the student some knowledge of the principles of the science which makes our civilization possible (11T). The student learns the way in which scientific discoveries have affected society (14T).</p>	<p>The student acquires the ability to interpret and adjust himself to the problems of modern living which have technological implications (21B).</p>
<p>b) The educated citizen has a regard for the nation's resources.</p>	<p>The student appreciates the service of chemistry to agriculture and industry (4A).</p>	<p>The student appreciates the service of chemistry to agriculture and industry (2T).</p>	<p>Chemistry helps the student to understand man's use of material and natural resources and the economic and social effects thereof (17B).</p>
<p>c) The educated citizen measures scientific advance by its contribution to the general welfare.</p>	<p>The student becomes aware of the contribution of chemistry to our way of living (8A).</p>	<p>The student appreciates more the practical value of chemistry in supplying many of the comforts of modern life (2T). Chemistry develops a deep respect for new chemical discoveries (2T).</p>	<p>Chemistry gives the student an understanding of the social and economic structure of an industrial civilization (19B).</p>

## CHAPTER V

### SUMMARY AND CONCLUSIONS

An analysis of twenty-seven articles by authorities in chemical education, twelve textbooks for high-school chemistry, and twenty-three books by education experts show that:

1. A course in high-school chemistry has possibilities for cultural and social values.

2. There is far from a concensus of opinion as to what these values are. Some authorities mention one or two, while others mention as many as eight or nine. There are, however, no contradictory statements.

3. None of the authorities quoted claim to have named all the cultural and social values of high-school chemistry, neither do they state which are the most important.

4. Some of the values are stated in broad, general terms and may also be realized by other areas of high-school instruction. Values stated by authorities in broad terms are:

- (a) The student acquires appreciation of the fine and the beautiful.
- (b) He lives and acts with greater satisfaction.
- (c) His mental horizon is broadened.
- (d) His chances for success are increased.
- (e) His leisure-time interests are satisfied.
- (f) He receives vocational guidance.
- (g) He is furnished with ideals.
- (h) His mental attitude is often changed.

(i) His life is enriched.

(j) He derives enjoyment.

5. Other values of chemistry are stated very specifically. They are peculiar to chemistry and are therefore not easily duplicated by other subjects in the present high-school curriculum. The specific values of high-school chemistry proposed by authorities are:

(a) The student acquires an appreciation of the contributions of chemistry to modern civilization, medicine, health, safety, agriculture, and industry.

(b) The student acquires an appreciation for the labors and achievements of chemists.

(c) The student learns to appreciate law and order in nature.

(d) He understands better the ways in which chemistry affects human life.

(e) He can better understand current literature dealing with chemical knowledge.

(f) He understands the relation of chemistry to other subjects.

(g) He understands his material and natural environment.

(h) He understands the obligations science places upon him.

(i) He acquires an increased respect for new chemical discoveries.

(j) He derives inspiration from the lives of chemists.

(k) He becomes an intelligent consumer of technical services and goods.

(l) He is provided with interesting topics for conversation.

(m) He often experiences the thrill of discovery.

6. The value most frequently mentioned is a better understanding of one's material and natural environment. The frequency with which this value

is mentioned, however, is no indication as to its importance. The value receiving the next most frequent mention is an appreciation of the labors and achievements of chemists.

7. Of all the values proposed the various appreciations are most frequently stressed.

8. The cultural and social values of high-school chemistry satisfy twelve of the objectives for education set by the Educational Policies Commission. These objectives describe the educated individual, the educated producer, the educated consumer, and the educated citizen. The twelve objectives used as criteria are:

- (a) The educated person has an appetite for learning.
- (b) The educated person can speak the mother tongue clearly.
- (c) The educated person understands the basic facts concerning health and disease.
- (d) The educated person protects his own health and that of his dependents.
- (e) The educated person has mental resources for the use of leisure.
- (f) The educated person appreciates beauty.
- (g) The educated producer knows the satisfaction of good workmanship.
- (h) The educated producer has selected his chosen vocation.
- (i) The educated consumer develops standards for guiding his expenditures.
- (j) The educated citizen seeks to understand social structure and social processes.
- (k) The educated citizen has a regard for the nation's resources.



(1) The educated citizen measures scientific advance by its contribution to the general welfare.

Since educational psychologists hold that attitudes, appreciations, and understandings are more effectively and more satisfactorily developed when the teacher makes a definite and conscious effort toward their development, students should be greatly benefitted if chemistry teachers possessed a list of the cultural and social values of chemistry and thus were made aware of them.

Further investigation might be made to determine what the opinion of high-school chemistry teacher is with reference to cultural and social values of chemistry. A study of this nature might attempt to answer the following questions: What values are considered cultural and social by teachers of chemistry? Do the teacher make an effort toward their realization? What educational procedures and instructional methods do teachers employ in order to realize these values?

An investigation might also be made to determine the relative importance of the different values as well as the extent to which the values are actually realized in the lives of the pupils. However, since as yet no satisfactory devices exist for measuring attitudes and appreciations, this last phase of the problem must await solution until such time when more adequate devices for measuring attitudes and appreciations have been constructed.

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## APPENDIX

TABLE IX

PERIODICALS AND THE NUMBER OF ARTICLES ANALYZED FROM EACH

Periodicals	Number of Articles
<u>Education</u>	1
<u>Educational Method</u>	1
<u>Journal of Chemical Education</u>	5
<u>School Science and Mathematics</u>	10
<u>Science Education</u>	3
<u>Science Counselor</u>	4
<u>Science Teacher</u>	2
<u>Science</u>	1
Total:	27

TABLE X

WHERE THE CULTURAL AND SOCIAL VALUES OF CHEMISTRY  
PROPOSED BY AUTHORS OF TEXTBOOKS ARE STATED

Symbol	In the Preface	In an Intro- ductory Chapter	In an Introductory Note Preceding Each Unit
1T	x	x	
2T	x	x	x
3T	x	x	x
4T	x	x	
5T	x		
6T	x	x	
7T	x		
8T	x	x	x
9T	x	x	
10T	x	x	
11T	x		
12T	x	x	
13T	x		
14T	x		
Total:	14	9	3

The thesis, "Cultural and Social Values of High-School Chemistry", written by Sister Mary Josephine Kortman, S.S.N.D., has been accepted by the Graduate School with reference to form, and by the readers whose names appear below, with reference to content. It is, therefore, accepted in partial fulfillment of the requirements for the degree of Master of Arts.

Rev. Austin G. Schmidt, S.J., Ph.D.	February 18, 1941
Rev. John R. Gleason, Ph.D.	February 18, 1941
Harold Wren, Ph.D.	February 18, 1941